

RESOLUTION MEPC.300(72)
(adopted on 13 April 2018)

CODE FOR APPROVAL OF BALLAST WATER MANAGEMENT SYSTEMS
(BWMS CODE)

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

RECALLING Article 38(a) of the Convention on the International Maritime Organization concerning the functions of the Marine Environment Protection Committee conferred upon it by international conventions for the prevention and control of marine pollution from ships,

NOTING that regulation D-3 of the Annex to the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (the BWM Convention), provides that ballast water management systems used to comply with the Convention must be approved by the Administration,

NOTING ALSO that it adopted, by resolution MEPC.125(53), *Guidelines for approval of ballast water management systems* (Guidelines (G8)), and by resolutions MEPC.174(58) and MEPC.279(70) revisions thereof,

DESIRING to make the Guidelines (G8) mandatory under the BWM Convention in the form of a code for approval of ballast water management systems,

NOTING resolution MEPC.296(72), by which it adopted amendments to regulations A-1 and D-3 of the BWM Convention to make the provisions of the Code for Approval of Ballast Water Management Systems referred to above mandatory,

RECALLING that it agreed, at its sixty-eighth session, to provisions for non-penalization of early movers that have installed ballast water management systems approved taking into account resolutions MEPC.125(53) and MEPC.174(58), as contained in the Roadmap for the implementation of the BWM Convention,

BEARING IN MIND the Organization's established practice with regard to the validity of type approval certification for marine products (MSC.1/Circ.1221), which is that the Type Approval Certificate itself has no influence on the operational validity of existing ballast water management systems approved and installed on board a ship and manufactured during the period of validity of the relevant Type Approval Certificate, meaning that the system need not be renewed or replaced due to expiration of such Certificate,

HAVING CONSIDERED, at its seventy-second session, the draft Code for Approval of Ballast Water Management Systems,

1 ADOPTS the *Code for Approval of Ballast Water Management Systems (BWMS Code)*, as set out in the annex to the present resolution;

2 INVITES Parties to the BWM Convention to note that the BWMS Code will take effect on 13 October 2019 upon entry into force of the associated amendments to the BWM Convention;

3 AGREES to keep the BWMS Code under review in the light of experience gained with its application and to amend it as necessary;

4 DECIDES that ballast water management systems approved not later than 28 October 2018, taking into account the Guidelines (G8) adopted by resolution MEPC.174(58), may be installed on board ships before 28 October 2020;

5 RESOLVES that, for the purpose of operative paragraph 4 of this resolution, the word "installed" means the contractual date of delivery of the ballast water management system to the ship. In the absence of such a date, the word "installed" means the actual date of delivery of the ballast water management system to the ship;

6 RESOLVES that references to the Guidelines (G8) and 2016 Guidelines (G8) in existing IMO instruments should be read to mean references to the BWMS Code;

7 AGREES that the dates referenced in this resolution will be considered in any reviews carried out in accordance with regulation D-5 of the BWM Convention, to determine whether a sufficient number of appropriate technologies are approved and available;

8 RESOLVES to revoke the *2016 Guidelines for approval of ballast water management systems* (G8) adopted by resolution MEPC.279(70) when the BWMS Code takes effect;

9 REQUESTS the Secretary-General to transmit certified copies of the present resolution and the text of the BWMS Code contained in the annex to all Parties to the BWM Convention;

10 REQUESTS FURTHER the Secretary-General to transmit copies of the present resolution and the text of the BWMS Code contained in the annex to the Members of the Organization which are not Parties to the BWM Convention.

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CODE FOR APPROVAL OF BALLAST WATER MANAGEMENT SYSTEMS (BWMS CODE)

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1 INTRODUCTION

General

1.1 The Code for Approval of Ballast Water Management Systems (BWMS Code) is aimed primarily at Administrations, or their designated bodies, in order to assess whether ballast water management systems (BWMS) meet the standard set out in regulation D-2 of the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (the Convention). In addition, the Code is intended for manufacturers and shipowners as a reference on the evaluation procedure that equipment will undergo and the requirements placed on BWMS. The Code should be applied in an objective, consistent and transparent way and its application should be evaluated periodically by the Organization.

1.2 Articles and regulations referred to in this Code are those contained in the Convention.

1.3 The Code includes general requirements concerning the design, installation, performance, testing, environmental acceptability, technical procedures for evaluation and procedures for issuance of Type Approval Certificates of BWMS and reporting to the Organization.

1.4 The Code is intended to fit within an overall framework for evaluating the performance of systems that includes the experimental shipboard evaluation of prototype systems under the provisions of regulation D-4, approval of BWMS and associated systems that comply fully with the requirements of the Convention, and port State control sampling for compliance under the provisions of article 9 of the Convention.

1.5 The approval requirements of regulation D-3 stipulate that BWMS used to comply with the Convention must be approved by the Administration, in accordance with this Code. In addition to such BWMS approval, as set forth in regulation A-2 and regulation B-3, the Convention requires that discharges of ballast water from ships must meet the regulation D-2 performance standard on an on-going basis. Approval of a system is intended to screen out BWMS that would fail to meet the standards prescribed in regulation D-2 of the Convention. Approval of a system, however, does not ensure that a given system will work on all ships or in all situations. To satisfy the Convention, a discharge must comply with the D-2 standard throughout the life of the ship.

1.6 BWMS shall be designed to not impair the health and safety of the ship or personnel, nor to present any unacceptable harm to the environment or to public health.

1.7 BWMS shall meet the standards of regulation D-2 and the conditions established in regulation D-3 of the Convention. The Code serves to evaluate the safety, environmental acceptability, practicability and biological effectiveness of the systems designed to meet these standards and conditions. The cost effectiveness of type-approved equipment will be used in determining the need for revisions of the Code.

1.8 To achieve consistency in its application, the approval procedure requires that a uniform manner of testing, analysis of samples, and evaluation of results is developed and applied. Amendments to this Code shall be duly circulated by the Secretary-General. Due consideration shall be given to the practicability of the BWMS.

Goal and purpose

1.9 The goal of the Code is to ensure uniform and proper application of the standards contained in the Convention. As such the Code should be updated as the state of knowledge and technology may require.

1.10 The purpose of the Code is to provide a uniform interpretation and application of the requirements of regulation D-3 and to:

- .1 define test and performance requirements for the approval of BWMS;
- .2 set out appropriate design, construction and operational parameters necessary for the approval of BWMS;
- .3 provide direction to Administrations, equipment manufacturers and shipowners in determining the suitability of equipment to meet the requirements of the Convention and of the environmental acceptability of treated water; and
- .4 ensure that BWMS approved by Administrations are capable of achieving the standard of regulation D-2 in land-based and shipboard evaluations and do not cause unacceptable harm to the ship, the crew, the environment or public health.

Applicability

1.11 This Code applies to the approval of BWMS in accordance with the Convention.

1.12 This Code applies to BWMS intended for installation on board all ships required to comply with regulation D-2.

1.13 BWMS approved taking into account the 2016 Guidelines (G8) adopted by resolution MEPC.279(70) shall be deemed to be in accordance with the BWMS Code.

2 BACKGROUND

2.1 The requirements of the Convention relating to approval of BWMS used by ships are set out in regulation D-3.

2.2 Regulation D-2 stipulates that ships conducting ballast water management in accordance with the ballast water performance standard of the Convention shall discharge:

- .1 less than 10 viable organisms per cubic metre greater than or equal to 50 µm in minimum dimension;
- .2 less than 10 viable organisms per millilitre less than 50 µm in minimum dimension and greater than or equal to 10 µm in minimum dimension; and
- .3 less than the following concentrations of indicator microbes, as a human health standard:
 - .1 Toxicogenic *Vibrio cholerae* (serotypes O1 and O139) with less than 1 colony forming unit (cfu) per 100 mL or less than 1 cfu per 1 g (wet weight) of zooplankton samples;

- .2 *Escherichia coli* less than 250 cfu per 100 mL; and
- .3 Intestinal Enterococci less than 100 cfu per 100 mL.

3 DEFINITIONS

For the purpose of this Code:

3.1 *Active Substance* means a substance or organism, including a virus or a fungus, that has a general or specific action on or against harmful aquatic organisms and pathogens.

3.2 *Ballast water management system* (BWMS) means any system which processes ballast water such that it meets or exceeds the ballast water performance standard in regulation D-2. The BWMS includes ballast water treatment equipment, all associated control equipment, piping arrangements as specified by the manufacturer, control and monitoring equipment and sampling facilities. For the purpose of this Code, BWMS does not include the ship's ballast water fittings, which may include piping, valves, pumps, etc., that would be required if the BWMS was not fitted.

3.3 *Ballast water management plan* means the plan referred to in regulation B-1 of the Convention describing the ballast water management process and procedures implemented on board individual ships.

3.4 *Control and monitoring equipment* means the equipment installed for the effective operation and control of the BWMS and the assessment of its effective operation.

3.5 *Convention* means the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004.

3.6 *Failed test cycle* is a valid test cycle in which the performance of the BWMS resulted in treated water that is determined to be non-compliant with the standard set within regulation D-2. A failed test cycle interrupts the required consecutive test cycles and terminates the test.

3.7 *Invalid test cycle* is a test cycle in which, due to circumstances outside the control of the BWMS, the requirements for a valid test cycle are not met. When a test cycle is invalid, it does not count as one of the required consecutive test cycles in a test and the test can be continued.

3.8 *Land-based testing* means a test of the BWMS carried out in a laboratory, equipment factory or pilot plant including a moored test barge or test ship, according to Parts 2 and 3 of the annex to this Code, to confirm that the BWMS meets the ballast water performance standard described in regulation D-2 of the Convention.

3.9 *Major components* means those components that directly affect the ability of the system to meet the ballast water performance standard described in regulation D-2.

3.10 *Representative sampling* means sampling that reflects the relative concentrations (chemicals) and numbers and composition of the populations (organisms) in the volume of interest. Samples shall be taken in a time-integrated manner and the sampling facility shall be installed, taking into account guidelines developed by the Organization

3.11 *Sampling facilities* refers to the means provided for sampling treated or untreated ballast water as needed in this Code and in the guidelines developed by the Organization.

3.12 *Shipboard testing* means a full-scale test of a complete BWMS carried out on board a ship according to part 2 of the annex to this Code, to confirm that the system meets the standards set by regulation D-2 of the Convention.

3.13 *Successful test cycle* means a valid test cycle where the BWMS functions to its specifications and treated water is determined to meet the ballast water performance standard described in regulation D-2.

3.14 *System Design Limitations* (SDL) of a BWMS means the water quality and operational parameters, determined in addition to the required type approval testing parameters, that are important to its operation, and, for each such parameter, a low and/or a high value for which the BWMS is designed to achieve the performance standard of regulation D-2. The SDL should be specific to the processes being employed by the BWMS and should not be limited to parameters otherwise assessed as part of the type approval process. The SDL should be identified by the manufacturer and validated under the supervision of the Administration, taking into account Guidance developed by the Organization, and in accordance with this Code.

3.15 *Test cycle* refers to one testing iteration (to include uptake, treatment, holding and discharge as appropriate) under a given set of requirements used to establish the ability of a BWMS to meet the set standards.

3.16 *Test* means the set of required test cycles.

3.17 *Treatment Rated Capacity* (TRC) means the maximum continuous capacity expressed in cubic metres per hour for which the BWMS is type-approved. It states the amount of ballast water that can be treated per unit time by the BWMS to meet the ballast water performance standard in regulation D-2. The TRC is measured at the inlet of the BWMS.

3.18 *Valid test cycle* means a test cycle in which all the required test conditions and arrangements, including challenge conditions, test control, and monitoring arrangements (including piping, mechanical and electrical provisions) and test analytical procedures were achieved by the test organization.

3.19 *Viable organisms* means organisms that have the ability to successfully generate new individuals in order to reproduce the species.

4 TECHNICAL SPECIFICATIONS

4.1 This section details the general technical requirements which a BWMS shall meet in order to obtain type approval.

General principles for operation

4.2 A BWMS shall be effective in meeting the D-2 standard on short voyages and long voyages (i.e. short and long intervals between treatment and discharge), regardless of temperature, unless the system is intentionally constructed for use in specific waters.

4.3 Ballast water discharged following treatment shall be safe for the environment on short voyages and long voyages (i.e. short and long intervals between treatment and discharge), regardless of temperature.

4.4 The design of the BWMS shall account for the fact that, regardless of the BWMS technology employed, viable organisms remaining after treatment may reproduce in the interval between treatment and discharge.

Ballast water management systems

4.5 The BWMS shall be designed and constructed:

- .1 for robust and suitable operation in the shipboard environment;
- .2 for the service for which it is intended;
- .3 to mitigate any danger to persons on board when installed. Equipment that could emit dangerous gases/liquids shall have at least two independent means of detection and shutdown of the BWMS (i.e. hazardous gas level reaching lower explosive limits (LEL) or level of toxic concentrations that can result in severe effects on human health); and
- .4 with materials compatible with: the substances used; the purpose for which it is intended; the working conditions to which it will be subjected; and the environmental conditions on board.

4.6 The BWMS shall not contain or use any substance of a dangerous nature, unless adequate risk mitigation measures are incorporated for storage, application, installation and safe handling, acceptable to the Administration.

4.7 In case of any failure compromising the proper operation of the BWMS, audible and visual alarm signals shall be given in all stations from which ballast water operations are controlled.

4.8 All working parts of the BWMS that are liable to wear or to be damaged shall be easily accessible for maintenance. The routine maintenance of the BWMS and troubleshooting procedures shall be clearly defined by the manufacturer in the operation, maintenance and safety manual. All maintenance and repairs shall be recorded.

4.9 To avoid interference with the BWMS, the following items shall be included:

- .1 every access of the BWMS beyond the essential requirements of paragraph 4.8 shall require the breaking of a seal;
- .2 if applicable, the BWMS shall be so constructed that a visual indication is always activated whenever the BWMS is in operation for purposes of cleaning, calibration or repair, and these events shall be recorded by the control and monitoring equipment; and
- .3 the BWMS shall be provided with the necessary connections to ensure that any bypass of the BWMS will activate an alarm, and that the bypass event is recorded by the control and monitoring equipment.

4.10 Facilities shall be provided for checking, at the renewal surveys and according to the manufacturer's instructions, the performance of the BWMS components that take measurements. A calibration certificate certifying the date of the last calibration check shall be retained on board for inspection purposes. Only the manufacturer or persons authorized by the manufacturer shall perform the accuracy checks.

4.11 The BWMS shall be provided with simple and effective means for its operation and control. It shall be provided with a control system that shall be such that the services needed for the proper operation of the BWMS are ensured through the necessary arrangements.

4.12 The BWMS shall, if intended to be fitted in hazardous area locations, comply with the relevant safety regulations for such spaces. Any electrical equipment that is part of the BWMS shall be based in a non-hazardous area, or shall be certified by the Administration as safe for use in a hazardous area. Any moving parts, which are fitted in hazardous areas, shall be arranged so as to avoid the formation of static electricity.

4.13 The BWMS shall be designed so as not to endanger the health and safety of the crew, interact negatively with the ship's systems and cargo or produce any adverse environmental effects. The BWMS shall not create long-term impacts on the safety of the ship and crew through corrosive effects in the ballast system and other spaces.

4.14 It shall be demonstrated, by using mathematical modelling and/or calculations, that any up or down scaling of the BWMS will not affect the functioning and effectiveness on board a ship of the type and size for which the equipment will be certified. In doing so, the manufacturer of the equipment shall take into account the relevant guidance developed by the Organization.

4.15 Scaling information shall allow the Administration to verify that any scaled model is at least as robust as the land-based-tested model. It is the responsibility of the Administration to verify that the scaling used is appropriate for the operational design of the BWMS.

4.16 At a minimum, the shipboard test unit shall be of a capacity that allows for further validation of the mathematical modelling and/or calculations for scaling, and preferably selected at the upper limit of the rated capacity of the BWMS, unless otherwise approved by the Administration.

Control and monitoring equipment

4.17 Administrations shall ensure that type-approved BWMS have a suitable control and monitoring system that will automatically monitor and record sufficient data to verify correct operation of the system. The control and monitoring equipment shall record the proper functioning or failure of the BWMS. Where practical, SDL parameters should be monitored and recorded by the BWMS to ensure proper operation.

4.18 The BWMS shall incorporate control equipment that automatically monitors and adjusts necessary treatment dosages or intensities or other aspects of the BWMS of the ship, which while not directly affecting treatment, are nonetheless required for proper administration of the necessary treatment.

4.19 The equipment shall be able to produce (e.g. display, print or export) a report of the applicable self-monitoring parameters in accordance with part 5 of the annex for official inspections or maintenance, as required.

4.20 To facilitate compliance with regulation B-2, the control and monitoring equipment shall also be able to store data for at least 24 months. In the event that the control and monitoring equipment is replaced, means shall be provided to ensure the data recorded prior to replacement remains available on board for 24 months.

4.21 For BWMS that could emit dangerous gases, a means of gas detection by redundant safety systems shall be fitted in the space of the BWMS, and an audible and visual alarm shall be activated at a local area and at a manned BWMS control station in case of leakage. The gas detection device shall be designed and tested in accordance with IEC 60079-29-1 or other recognized standards acceptable to the Administration. Monitoring measures for dangerous gases with independent shutdown shall be provided on the BWMS.

4.22 All software changes introduced to the system after the pre-test evaluation shall be done according to a change handling procedure ensuring traceability.

5 TYPE APPROVAL PROCESS

5.1 The type approval requirements for BWMS are as described below.

5.2 The manufacturer of the equipment shall submit information regarding the design, construction, operation and functioning of the BWMS in accordance with Part 1 of the annex, including information regarding the water quality and operational parameters that are important to the operation of the system. This information shall be the basis for a first evaluation of suitability by the Administration.

5.3 Following the Administration's pre-test evaluation, the BWMS shall undergo land-based, shipboard and other tests in accordance with the procedures described in Parts 2 and 3 of the annex. The BWMS tested for type approval shall be a final and complete product that meets the requirements of section 4 and it shall be constructed using the same materials and procedures that will be used to construct production units.

5.4 Successful fulfilment of the requirements and procedures outlined in Parts 2 and 3 of the annex, as well as all other requirements of this Code, shall lead to the issuance of a Type Approval Certificate by the Administration in accordance with section 6.

5.5 The limitations of the BWMS, in addition to the required type approval testing parameters identified in paragraphs 2.29 and 2.46 of the annex, as submitted by its manufacturer and validated by the Administration, shall be documented on the Type Approval Certificate. These design limitations do not determine if the equipment may be type-approved or not, but provide information on the conditions beyond the type approval testing parameters under which proper functioning of the equipment can be expected.

5.6 When a type-approved BWMS is installed on board, an installation survey according to section 8 shall be carried out.

5.7 The documentation submitted for approval shall include at least the following:

- .1 a description and diagrammatic drawings of the BWMS;
- .2 the operation, maintenance and safety manual;
- .3 hazard identification;
- .4 environmental and public health impacts; and
- .5 System Design Limitations.

6 APPROVAL AND CERTIFICATION PROCEDURES

6.1 A BWMS which in every respect fulfils the requirements of this Code may be approved by the Administration for fitting on board ships. The approval shall take the form of a Type Approval Certificate of BWMS, specifying the main particulars of the BWMS and validated SDL. Such certificates shall be issued in accordance with Part 7 of the annex in the format shown in the appendix.

6.2 A BWMS that in every respect fulfils the requirements of this Code except that it has not been tested at all the temperatures and salinities set out in Part 2 of the annex shall only be approved by the Administration if corresponding limiting operating conditions are clearly stated on the issued Type Approval Certificate with the description "Limiting Operating Conditions". For the limiting values, the SDL shall be consulted.

6.3 A Type Approval Certificate of a BWMS shall be issued for the specific application for which the BWMS is approved, e.g. for specific ballast water capacities, flow rates, salinity or temperature regimes, or other limiting operating conditions or circumstances as appropriate.

6.4 A Type Approval Certificate of a BWMS shall be issued by the Administration based on satisfactory compliance with all the requirements described in Parts 1, 2, 3 and 4 of the annex.

6.5 The SDL shall be specified on the Type Approval Certificate in a table that identifies each water quality and operational parameter together with the validated low and/or high parameter values for which the BWMS is designed to achieve the ballast water performance standard described in regulation D-2.

6.6 An Administration may issue a Type Approval Certificate of a BWMS based on testing already carried out under supervision by another Administration. In cases where the approval of a BWMS by an Administration for installation on a ship operating under its authority is to be granted on the basis of testing carried out by another Administration, the approval may be conveyed through the issuance of the International Ballast Water Management Certificate.

6.7 A Type Approval Certificate shall only be issued to a BWMS that has been determined by the Administration to make use of an Active Substance after it has been approved by the Organization in accordance with regulation D-3.2. In addition, the Administration shall ensure that any recommendations that accompanied the Organization's approval have been taken into account before issuing the Type Approval Certificate.

6.8 The Type Approval Certificate shall be issued taking into account guidance developed by the Organization.

6.9 An approved BWMS may be type approved by other Administrations for use on their ships. Should a BWMS approved by one country fail type approval in another country, then the two countries concerned shall consult one another with a view to reaching a mutually acceptable agreement.

6.10 An Administration approving a BWMS shall promptly provide a type-approval report to the Organization in accordance with part 6 of the annex. Upon receipt of a type-approval report, the Organization shall promptly make it available to the public and Member States by appropriate means.

6.11 In the case of a type approval based entirely on testing already carried out under supervision by another Administration, the type-approval report shall be prepared and kept on file and the Organization shall be informed of the approval.

6.12 In the case of a BWMS that was previously type-approved by an Administration taking into account the revised Guidelines (G8) adopted by resolution MEPC.174(58), the manufacturer, in seeking a new type approval under this Code, shall only be requested to submit to the Administration the additional test reports and documentation set out in this Code.

7 INSTALLATION REQUIREMENTS FOLLOWING TYPE APPROVAL

7.1 The BWMS shall be accompanied by sampling facilities installed taking into account guidelines developed by the Organization, so arranged in order to collect representative samples of the ship's ballast water discharge.

7.2 Suitable bypasses or overrides to protect the safety of the ship and personnel shall be installed and used in the event of an emergency and these shall be connected to the BWMS so that any bypass of the BWMS shall activate an alarm. The bypass event shall be recorded by the control and monitoring equipment and within the ballast water record book.

7.3 The requirement in paragraph 7.2 does not apply to internal transfer of ballast water within the ship (e.g. anti-heeling operations). For BWMS that transfer water internally which may affect compliance by the ship with the standard described in regulation D-2 (i.e. circulation or in-tank treatment) the recording in paragraph 7.2 shall identify such internal transfer operations.

8 INSTALLATION SURVEY AND COMMISSIONING PROCEDURES FOLLOWING TYPE APPROVAL

8.1 The additional information outlined in the paragraphs below is intended to facilitate ship operations and inspections and assist ships and Administrations in preparing for the procedures set out in the *Survey Guidelines for the purpose of the International Convention for the Control and Management of Ships' Ballast Water and Sediments under the Harmonized System of Survey and Certification*, developed by the Organization, which describe the examination of plans and designs and the various surveys required under regulation E-1.

8.2 The Administration issuing the International Ballast Water Management Certificate shall verify that the following documentation is on board in a suitable format:

- .1 for the purpose of information, a copy of the Type Approval Certificate of the BWMS;
- .2 the operation, maintenance and safety manual of the BWMS;
- .3 the ballast water management plan of the ship;
- .4 installation specifications, e.g. installation drawing, piping and instrumentation diagrams, etc.; and
- .5 installation commissioning procedures.

8.3 Prior to the issuance of the International Ballast Water Management Certificate, following the installation of a BWMS, the Administration should verify that:

- .1 the BWMS installation has been carried out in accordance with the technical installation specification referred to in paragraph 8.2.4;
- .2 the BWMS is in conformity with the relevant Type Approval Certificate BWMS;
- .3 the installation of the complete BWMS has been carried out in accordance with the manufacturer's equipment specification;
- .4 any operational inlets and outlets are located in the positions indicated on the drawing of the pumping and piping arrangements;

- .5 the workmanship of the installation is satisfactory and, in particular, that any bulkhead penetrations or penetrations of the ballast system piping are to the relevant approved standards; and
- .6 the installation commissioning procedures have been completed.

ANNEX

PART 1 – SPECIFICATIONS FOR PRE-TEST EVALUATION OF SYSTEM DOCUMENTATION

1.1 Adequate documentation shall be prepared and submitted to the Administration and be shared with the test organization as part of the approval process well in advance of the intended approval testing of a BWMS. Approval of the submitted documentation shall be a prerequisite for carrying out independent approval tests.

1.2 Documentation shall be provided by the manufacturer/developer for two primary purposes: evaluating the readiness of the BWMS for undergoing approval testing and evaluating the manufacturer's proposed SDL and validation procedures.

Documentation

1.3 The documentation to be submitted as a part of the readiness evaluation shall include at least the following:

- .1 a BWMS technical specification, including at least:
 - .1 a description of the BWMS, treatment processes it employs and details of any required permits;
 - .2 adequate information including descriptions and diagrammatic drawings of the pumping and piping arrangements, electrical/electronic wiring, monitoring system, waste streams and sampling points. Such information should enable fault finding;
 - .3 details of major components and materials used (including certificates where appropriate);
 - .4 an equipment list showing all components subject to testing including specifications, materials and serial numbers;
 - .5 an installation specification in accordance with manufacturers installation criteria requirements for the location and mounting of components, arrangements for maintaining the integrity of the boundary between safe and hazardous spaces and the arrangement of the sample piping;
 - .6 information regarding the characteristics and arrangements in which the system is to be installed, including scope of the ships (sizes, types and operation) for which the system is intended. This information may form the link between the system and the ship's ballast water management plan; and
 - .7 a description of BWMS side streams (e.g. filtered material, centrifugal concentrate, waste or residual chemicals) including a description of the actions planned to properly manage and dispose of such wastes;

- .2 the operation, maintenance and safety manual, including at least:
 - .1 instructions for the correct operation of the BWMS, including procedures for the discharge of untreated water in the event of malfunction of the ballast water treatment equipment;
 - .2 instructions for the correct arrangement of the BWMS;
 - .3 maintenance and safety instructions and the need to keep records;
 - .4 troubleshooting procedures;
 - .5 emergency procedures necessary for securing the ship;
 - .6 any supplementary information considered necessary for the safe and efficient operation of the BWMS, e.g. documentation provided for approval under the *Procedure for approval of ballast water management systems that make use of Active Substances (G9)* (resolution MEPC.169(57)); and
 - .7 calibration procedures;
- .3 information on any hazard identification conducted to identify potential hazards and define appropriate control measures, if the BWMS or the storage tanks for processing chemicals could emit dangerous gases or liquids;
- .4 information regarding environmental and public health impacts including:
 - .1 identification of potential hazards to the environment based on environmental studies performed to the extent necessary to assure that no harmful effects are to be expected;
 - .2 in the case of BWMS that make use of Active Substances or Preparations containing one or more Active Substances, the dosage of any Active Substances used and the maximum allowable discharge concentrations;
 - .3 in the case of BWMS that do not make use of Active Substances or preparations, but which could reasonably be expected to result in changes to the chemical composition of the treated water such that adverse impacts to receiving waters might occur upon discharge, the documentation shall include results of toxicity tests of treated water as described in paragraph 2.19 of this annex; and
 - .4 sufficient information to enable the test organization to identify any potential health or environmental safety problems, unusual operating requirements (labour or materials), and any issues related to the disposal of treatment by-products or waste streams;
- .5 information regarding SDL including:
 - .1 the identification of all known parameters to which the design of the BWMS is sensitive;

- .2 for each parameter the manufacturer shall claim a low and/or a high value for which the BWMS is capable of achieving the Performance Standard of regulation D-2; and
- .3 the proposed method for validating each claimed SDL shall be set out, together with information on the source, suitability and reliability of the method;
- .6 a software change handling and revision control document including all software changes introduced to the system after the pre-test evaluation. These shall be done according to a change handling procedure ensuring traceability. Therefore, the manufacturer shall present a procedure describing how changes are to be handled and how revision control is maintained. As a minimum for a modification request, the following types of information shall be produced and logged:
 - .1 reason for modification;
 - .2 specification of the proposed change;
 - .3 authorization of modification; and
 - .4 test record;
- .7 functional description including a textual description with necessary supporting drawings, diagrams and figures to cover:
 - .1 system configuration and arrangement;
 - .2 scope of supply;
 - .3 system functionality covering control, monitoring, alarm and safety functions;
 - .4 self-diagnostics and alarming functionalities; and
 - .5 safe states for each function implemented.

1.4 The documentation may include specific information relevant to the test set-up to be used for land-based testing according to this Code. Such information should include the sampling needed to ensure proper functioning and any other relevant information needed to ensure proper evaluation of the efficacy and effects of the equipment. The information provided should also address general compliance with applicable environment, health and safety standards during the type-approval procedure.

Readiness evaluation

1.5 During the readiness evaluation, the Administration shall ensure that each technical specification set out in section 4 of this Code has been met, other than those that will be assessed during later testing.

1.6 The readiness evaluation shall examine the design and construction of the BWMS to determine whether there are any fundamental problems that might constrain the ability of the BWMS to manage ballast water as proposed by the manufacturer, or to operate safely, on board ships.

1.7 Administrations shall ensure adequate risk assessments including the implementation of preventative actions have been undertaken relating to the safe operation of BWMS.

1.8 As a first step the manufacturer shall provide information regarding the requirements and procedures for installing, calibrating and operating (including maintenance requirements) the BWMS during a test. This evaluation should help the test organization to identify any potential health or environmental safety problems, unusual operating requirements (labour or materials), and any issues related to the disposal of treatment by-products or waste streams.

1.9 The test facility shall have a procedure to deal with deviations that occur prior to testing and an evaluation process which includes an assessment and validation process to address any unforeseen deviations that may occur during testing. Deviations from the testing procedure shall be fully reported.

1.10 During the readiness evaluation the major components of the BWMS shall be identified. Major components are considered to be those components that directly affect the ability of the system to meet the performance standard described in regulation D-2. Upgrades or changes to major components shall not take place during type approval testing. A change to a major component requires a new submission of the test proposal and shall involve a new evaluation and repeating of the land-based and shipboard tests.

1.11 The Administration may allow replacements of non-major components of equivalent specification (independently approved to a recognized and equal operational standard) during type approval. Replacements of non-major components during testing shall be reported.

1.12 Upgrades of the BWMS that relate to the safe operation of that system may be allowed during and after type approval and shall be reported. If such safety upgrades directly affect the ability of the system to meet the standard described in regulation D-2, it shall be treated as a change of a major component, as per paragraph 1.10 above.

1.13 The evaluation shall identify consumable components in the BWMS. The Administration may allow replacement of like-for-like consumable components during type approval testing and all replacements shall be reported.

System Design Limitation evaluation

1.14 The SDL evaluation shall be undertaken by the Administration. It shall assess the basis for the manufacturer's claim that the SDL include all known water quality and operational parameters to which the design of the BWMS is sensitive and that are important to its ability to achieve the performance standard described in regulation D-2.

1.15 The Administration shall also evaluate the suitability and reliability of the methods proposed for validating the claimed low and/or high values for each SDL. These methods may include tests to be undertaken during land-based, shipboard or bench-scale testing and/or the use of appropriate existing data and/or models.

PART 2 – TEST AND PERFORMANCE SPECIFICATIONS FOR APPROVAL OF BALLAST WATER MANAGEMENT SYSTEMS

2.1 The Administration decides the sequence of land-based and shipboard testing. The BWMS used for testing must be verified by the Administration to be the same as the BWMS described under Part 1 of the annex with major components as described in the documentation submitted in accordance with paragraphs 1.3.1.3 and 1.3.1.4 of this annex.

Quality assurance and quality control procedures

2.2 The test facility shall demonstrate its competency in conducting valid type approval tests in two ways:

- .1 by having implemented a rigorous quality control/quality assurance programme, approved, certified and audited by an independent accreditation body, or to the satisfaction of the Administration; and
- .2 by demonstrating its ability to conduct valid test cycles with appropriate challenge water, sample collection, sample analysis and method detection limits.

It is the responsibility of the Administration, or its authorized delegate, to determine the acceptability of the test facility.

2.3 The test facility's quality control/quality assurance programme shall consist of:

- .1 a Quality Management Plan (QMP), which addresses the quality control management structure and policies of the testing body (including subcontractors and outside laboratories);
- .2 a Quality Assurance Project Plan (QAPP), which defines the methods, procedures, and quality assurance and quality control (QA/QC) protocols used by the test facility for testing BWMS in general. It identifies the test team members, and it includes all relevant standard operating procedures (SOPs), typically as appendices; and
- .3 a Test/Quality Assurance Plan (TQAP), that provides specific details for conducting a test of a given BWMS at a given site and time. The TQAP includes detailed plans for commissioning the BWMS, the experimental plan, decommissioning, and reporting the results. The TQAP identifies all organizations involved in the test and includes the BWMS manufacturer's documentation and performance claims. The TQAP also identifies the data to be recorded, operational and challenge parameters that define a valid test cycle, data analyses to be presented in the verification report and a schedule for testing. Appropriate statistical distributions shall be considered and used to analyse data.

2.4 The test facility performing the BWMS tests shall be independent. It shall not be owned by or affiliated with the manufacturer or vendor of any BWMS, or by the manufacturer or supplier of the major components of that equipment.

Avoiding sampling bias

2.5 The sampling protocol must ensure organism mortality is minimized, e.g. by using appropriate valves and flow rates for flow control in the sampling facility, submerging nets during sampling collection, using appropriate sampling duration and handling times, and appropriate concentrating methodology. All methods to avoid sampling bias shall be validated to the satisfaction of the Administration.

Shipboard tests

2.6 A shipboard test cycle includes:

- .1 the uptake of ballast water of the ship;
- .2 treatment of the ballast water in accordance with paragraph 2.8.4 of this annex by the BWMS;
- .3 the storage of ballast water on the ship during a voyage; and
- .4 the discharge of ballast water from the ship.

2.7 Shipboard testing of BWMS shall be conducted by the test facility, independent of the BWMS manufacturer, with the system being operated and maintained by the ships' crew as per the operation, maintenance and safety manual.

Success criteria for shipboard testing

2.8 In evaluating the performance of BWMS installation(s) on a ship or ships, the following information and results shall be supplied to the satisfaction of the Administration:

- .1 test plan to be provided prior to testing;
- .2 documentation that an in-line BWMS is of a capacity to reflect the flow rate of the ballast water pump for the TRC of the BWMS;
- .3 documentation that an in-tank BWMS is of a capacity to reflect the ballast water volume that it is intended to treat within a specified period of time;
- .4 the amount of ballast water tested in the test cycle on board shall be consistent with the normal ballast operations of the ship and the BWMS shall be operated at the TRC for which it is intended to be approved;
- .5 documentation showing that the discharge of each valid test cycle was in compliance with regulation D-2. For a test to be valid, the uptake water for the ballast water to be treated shall contain a density of viable organisms exceeding 10 times the maximum permitted values in regulation D-2.1;
- .6 sampling regime and volumes for analysis:
 - .1 for the enumeration of viable organisms greater than or equal to 50 µm or more in minimum dimension:
 - .1 influent water shall be collected over the duration of uptake as one time-integrated sample. The sample shall be collected as a single, continuous sample or a composite of

sequential samples, e.g. collected at intervals during the beginning, middle and end of the operation. The total sample volume shall be at least 1 m³. If a smaller volume is validated to ensure representative sampling of organisms, it may be used;

- .2 treated discharged water shall be collected as one time-integrated sample over the duration of discharge from the tank(s). The sample may be collected as a single, continuous sample or a composite of sequential samples, e.g. collected throughout the beginning, middle and end the operation. The total sample volume shall be at least 3 m³;
 - .3 if samples are concentrated for enumeration, the organisms shall be concentrated using a mesh with holes no greater than 50 µm in the diagonal dimension. Only organisms greater than 50 µm in minimum dimension shall be enumerated; and
 - .4 the full volume of the sample shall be analysed unless the total number of organisms is high, e.g. 100. In this case, the average density may be extrapolated based on a well-mixed subsample using a validated method;
- .2 for the enumeration of viable organisms greater than or equal to 10 µm and less than 50 µm in minimum dimension:
- .1 influent water shall be collected over the duration of uptake as one, time-integrated sample. The sample shall be collected as a single, continuous sample or a composite of sequential samples, e.g. collected at intervals during the beginning, middle and end of the operation. A sample of at least 10 L shall be collected, and a fraction may be subsampled for transport to the laboratory, provided it is representative of the sample and is a minimum of 1 L. A minimum of three 1 mL subsamples shall be analysed in full to enumerate organisms;
 - .2 treated discharged water shall be collected as one time-integrated sample over the duration of discharge from the tank(s). The sample may be collected as a single, continuous sample or a composite of sequential samples, e.g. collected throughout the beginning, middle and end of the operation. A sample of at least 10 L shall be collected, and a fraction may be subsampled for transport to the laboratory, provided it is representative of the sample and is a minimum of 1 L. A minimum of six 1 mL subsamples shall be analysed in full to enumerate organisms;
 - .3 the sample may not be concentrated for analysis unless the procedure is validated. Only organisms greater than 10 µm and less than 50 µm in minimum dimension shall be enumerated; and

- .4 the full volume of the sample shall be analysed unless the total number of organisms is high, e.g. 100. In this case, the average density may be extrapolated based on a well-mixed subsample using a validated method;
- .3 for the evaluation of bacteria:
 - .1 for the influent and discharge samples, the minimum 10 L sample referred to in paragraphs 2.8.6.2.1 and 2.8.6.2.2, or another sample at least 10 L in volume and collected in a similar manner should be used, a subsample of minimum 1 L may be transferred to a sterile container for analysis;
 - .2 a minimum of three subsamples of appropriate volume taken from the 1 L subsample described above shall be analysed for colony forming units of bacteria listed in regulation D-2; and
 - .3 the toxicogenic test requirements shall be conducted in an appropriately approved laboratory. If no approved laboratory is available, the analysis method may be validated to the satisfaction of the Administration.
- .7 the test cycles including invalid test cycles shall span a period of not less than six months;
- .8 three consecutive test cycles in compliance with regulation D-2 are to be performed. Any invalid test cycle does not affect the consecutive sequence;
- .9 the six-month shipboard test period starts and ends with the completion of a successful test cycle or invalid test cycle that meets the D-2 standard. The three consecutive and valid test cycles that are required in paragraph 2.8.8 above must be suitably separated across the six-month period;
- .10 the source water for test cycles shall be characterized by measurement of salinity, temperature, particulate organic carbon, total suspended solids and dissolved organic carbon; and
- .11 for system operation throughout the test period, the following information shall also be provided:
 - .1 documentation of all ballast water operations including volumes and locations of uptake and discharge, and if heavy weather was encountered and where;
 - .2 documentation that the BWMS was operated continuously throughout the test period for all ballasting and deballasting of the ship;
 - .3 documentation detailing water quality parameters identified by the test organization that should be provided as appropriate and practicable;

- .4 the possible reasons for an invalid test cycle, or a test cycle discharge failing the D-2 standard, which shall be investigated and reported to the Administration;
- .5 documentation of scheduled maintenance performed on the system during the test period;
- .6 documentation of unscheduled maintenance and repair performed on the system during the test period;
- .7 documentation of engineering parameters, monitored as appropriate to the specific system; and
- .8 a report detailing the functioning of the control and monitoring equipment.

Land-based testing

2.9 The land-based testing provides data to determine the biological efficacy and environmental acceptability of the BWMS under consideration for type approval. The approval testing aims to ensure replicability and comparability to other treatment equipment.

2.10 Any limitations imposed by the BWMS on the testing procedure described here shall be duly noted and evaluated by the Administration.

2.11 The test set-up including the BWMS shall operate as described in the provided operation, maintenance and safety manual during at least five consecutive successful test cycles in each salinity.

2.12 A land-based test cycle shall include the uptake of ballast water by pumping, the storage of ballast water, treatment of ballast water within the BWMS (except in control tanks), and the discharge of ballast water by pumping. The order will be dependent on the BWMS.

2.13 At least two test cycles in each salinity tested shall be conducted in order to evaluate compliance with the D-2 standard at the minimum holding time specified by the BWMS manufacturer.

2.14 Test facilities carrying out identification of Relevant Chemicals and toxicity testing of the treated ballast water from test cycles with a storage time which is shorter or longer than five days shall ensure that sufficient volumes of treated water are collected after five days or are reserved after the efficacy testing to permit the requirements of guidelines developed by the Organization, for approval of BWMS making use of Active Substances, to be assessed for at least one test cycle per salinity.

2.15 Land-based testing of BWMS shall be independent of the system manufacturer.

2.16 Testing shall occur using different water conditions sequentially as provided for in paragraphs 2.29 and 2.31 of this annex.

2.17 The BWMS shall be tested at its TRC or as given in paragraphs 2.25 to 2.28 of this annex for each test cycle. The equipment shall function to specifications during this test.

2.18 The analysis of treated water discharge from each test cycle shall determine if the treated discharge meets regulation D-2.

2.19 The analysis of treated water discharge from the relevant test cycle(s) shall also be used to evaluate the formation of Relevant Chemicals as well as the toxicity of the discharged water for BWMS that make use of Active Substances. The same evaluation shall be conducted for those BWMS that do not make use of Active Substances or Preparations but which could reasonably be expected to result in changes to the chemical composition of the treated water such that adverse impacts to receiving waters might occur upon discharge. Toxicity tests of the treated water discharge shall be conducted, taking into account guidelines developed by the Organization.

Land-based testing set-up

2.20 The test set-up for approval tests shall be representative of the characteristics and arrangements of the types of ships in which the equipment is intended to be installed. The test set-up shall therefore include at least the following:

- .1 the complete BWMS to be tested;
- .2 piping and pumping arrangements; and
- .3 the storage tank that simulates a ballast tank, constructed such that the water in the tank shall be completely shielded from light.

2.21 The control and treated simulated ballast tanks shall each include:

- .1 a minimum capacity of 200 m³;
- .2 the use of standard industry practices for design and construction for ships; surface coatings shall be in accordance with the *Performance standard for protective coatings of dedicated seawater ballast tanks on all new ships and of double-sided skin spaces of bulk carriers* (PSPC) (resolution MSC.215(82)); and
- .3 the minimum modifications required for structural integrity on land.

2.22 The control and treated simulated ballast tanks should include normal internal structures, including lightening and drainage holes.

2.23 The test set-up shall be pressure-washed with tap water, dried and swept to remove loose debris, organisms and other matter before starting testing procedures, and between test cycles.

2.24 The test set-up shall include facilities to allow sampling as described in paragraphs 2.40 and 2.41 of this annex and provisions to supply influents to the system, as specified in paragraphs 2.29, 2.30, 2.33 and 2.34 of this annex. The installation arrangements shall conform in each case with those specified and approved under the procedure outlined in section 7 of this Code.

Ballast water management system scaling

2.25 Scaling of the BWMS should take into account guidance developed by the Organization. The Administration shall verify that the scaling used is appropriate for the operational design of the BWMS.

2.26 BWMS with at least one model with a TRC equal to or smaller than 200 m³/h shall not be downscaled.

2.27 For BWMS with at least one model that has a TRC higher than 200 m³/h or 1000 m³/h the following must be observed for land-based testing. In-line treatment equipment may be downsized for land-based testing, but only when the following criteria are taken into account:

- .1 BWMS with at least one model with a TRC higher than 200 m³/h but lower than 1,000 m³/h may be downscaled to a maximum of 1:5 scale, but may not be lower than 200 m³/h; and
- .2 BWMS with at least one model with a TRC equal to, or higher than, 1,000 m³/h may be downscaled to a maximum of 1:100 scale, but may not be lower than 200 m³/h.

2.28 In-tank treatment equipment shall be tested on a scale that allows verification of full-scale effectiveness. The suitability of the test set-up shall be evaluated by the manufacturer and approved by the Administration.

Land-based test design – inlet and outlet criteria

2.29 For any given set of test cycles (five are considered a set) a salinity range shall be chosen for each cycle. Given the salinity of the test set-up for a test cycle in fresh, brackish and marine water, each shall have dissolved and particulate content in one of the combinations set out in the table below. Deviations from the marine and brackish salinity ranges of the table shall be reported and justified and the resulting tests shall not be less challenging for the BWMS than would be the circumstance if the deviations had not occurred:

	Salinity		
	Marine 28 – 36 PSU	Brackish 10 – 20 PSU	Fresh < 1 PSU
Dissolved organic carbon (DOC)	> 1 mg/L	> 5 mg/L	> 5 mg/L
Particulate organic carbon (POC)	> 1 mg/L	> 5 mg/L	> 5 mg/L
Total suspended solids (TSS)	> 1 mg/L	> 50 mg/L	> 50 mg/L

2.30 The source of the test water shall be natural water. Any augmentation of test water with dissolved organic carbon (DOC), particulate organic carbon (POC) or total suspended solids (TSS) to achieve the minimum required content shall be validated and approved by the Administration. As natural DOC constituents are complex and primarily of aromatic character, the type of added DOC is particularly critical to the evaluation of BWMS performance. The validation shall ensure that relevant properties of the augmented water (such as the oxidant demand/TRO decay and UV absorption in the range of 200 to 280 nm, the production of disinfectant by-products and the particle size distribution of suspended solids) are equivalent, on a mg/L basis, to that of natural water that would quantitatively meet the challenge conditions. In addition, the validation shall ensure that augmentation does not bias a test for or against any specific treatment process. The test report shall include the basis for the selection, use and validation of augmentation.

2.31 The BWMS must be tested in conditions for which it will be approved. For a BWMS to achieve an unlimited Type Approval Certificate with respect to salinity, one set of test cycles shall be conducted within each of the three salinity ranges with the associated dissolved and particulate content as prescribed in paragraph 2.29 above. Tests under adjacent salinity ranges in the above table shall be separated by at least 10 PSU.

2.32 Use of standard test organisms (STO):

- .1 the use of standard test organisms (STO) is permissible if the challenge levels in naturally occurring water at the test facility require supplementation. The use of STO shall not be considered standard practice and the Administration shall in every case review that the selection, number and use of supplementary STOs ensures that the challenge posed to the BWMS provides an adequately robust test. The use of STOs shall not bias a test for or against any specific treatment process. They shall be locally isolated to ensure that the risk to the local environment is minimized; non-indigenous organisms which have the potential to cause harm to the environment shall not be used;
- .2 procedures, processes and guidance for the use of STO shall be based on the most relevant and up-to-date available scientific data. Such procedures, processes and guidance shall form a part of the testing facilities quality assurance regimes; and
- .3 the use of STO, including concentrations and species, shall be recorded within the test report. The test report shall include information pertaining to the evaluation and justification for the use of STO, an assessment of the impact of their use on other test parameters and potential impacts on the test being undertaken. The information contained within the report shall reflect both the positive and negative impacts of the use of STO.

2.33 The influent water shall include:

- .1 test organisms of greater than or equal to 50 μm or more in minimum dimension that shall be present in a total density of preferably 10^6 but not less than 10^5 individuals per cubic metre, and shall consist of at least five species from at least three different phyla/divisions;
- .2 test organisms greater than or equal to 10 μm and less than 50 μm in minimum dimension that shall be present in a total density of preferably 10^4 but not less than 10^3 individuals per mL, and shall consist of at least five species from at least three different phyla/divisions;
- .3 heterotrophic bacteria that shall be present in a density of at least 10^4 living bacteria per mL; and
- .4 a variety of organisms which shall be documented according to the size classes mentioned above regardless of whether natural organism assemblages or cultured organisms were used to meet the density and organism variety requirements.

2.34 The following bacteria do not need to be added to the influent water, but shall be measured at the influent and at the time of discharge:

- .1 coliform;
- .2 Enterococcus group;
- .3 *Vibrio cholerae*; and
- .4 heterotrophic bacteria.

2.35 If cultured test organisms are used, local applicable quarantine regulations shall be taken into account during culturing and discharge.

Land-based monitoring and sampling

2.36 Change of numbers of test organisms by treatment and during storage in the simulated ballast tank shall be measured using methods described in Part 4 of this annex (paragraphs 4.5 to 4.7).

2.37 It shall be verified that the treatment equipment performs within its specified parameters, such as power consumption and flow rate, during the test cycle.

2.38 The range of operational flow rates that a BWMS is expected to achieve in service, at the maximum and minimum operational flow rates (where it is appropriate for that technology), shall be verified after the filter on the discharge side of the pump. The range of flow rate may be derived from empirical testing or from computational modelling. Where appropriate for the technology, demonstration of system efficacy at low flow rates shall reflect the need for flow reduction during the final stages of ballast operations.

2.39 Environmental parameters such as pH, temperature, salinity, dissolved oxygen, TSS, DOC, POC and turbidity (Nominal Turbidity Unit, NTU) shall be measured at the same time that the samples described are taken.

2.40 Samples during the test for the purposes of determining biological efficacy shall be taken at the following times and locations: immediately before the treatment equipment, immediately after the treatment equipment and upon discharge after the appropriate holding time.

2.41 The control and treatment cycles may be run simultaneously or sequentially. Control samples are to be taken in the same manner as the equipment test as prescribed in paragraph 2.40 above and upon influent and discharge.

2.42 Facilities or arrangements for sampling shall be provided to ensure representative samples of treated and control water can be taken that introduce as little adverse effects as possible on the organisms.

2.43 Samples described in paragraphs 2.40 and 2.41 above shall be collected with the following sampling regime and volumes for analysis:

- .1 for the enumeration of viable organisms greater than or equal to 50 µm or more in minimum dimension:
 - .1 influent water shall be collected over the duration of uptake as one time-integrated sample. The sample shall be collected as a single, continuous sample or a composite of sequential samples, e.g. collected at intervals during the beginning, middle and end of the operation. The total sample volume shall be at least one cubic metre. If smaller volume is validated to ensure representative sampling of organisms, it may be used;
 - .2 control and treated discharged water shall be collected as one time-integrated sample over the duration of discharge from the tank(s). The sample may be collected as a single, continuous sample or a composite of sequential samples, e.g. collected

throughout the beginning, middle and end of the operation. The total sample volume shall be at least 3 m³;

- .3 if samples are concentrated for enumeration, the organisms shall be concentrated using a mesh with holes no greater than 50 µm in the diagonal dimension. Only organisms greater than 50 µm in minimum dimension shall be enumerated; and
 - .4 the full volume of the sample shall be analysed unless the total number of organisms is high, e.g. 100. In this case, the average density may be extrapolated based on a well-mixed subsample using a validated method;
- .2 for the enumeration of viable organisms greater than or equal to 10 µm and less than 50 µm in minimum dimension:
- .1 influent water shall be collected over the duration of uptake as one, time-integrated sample. The sample shall be collected as a single, continuous sample or a composite of sequential samples, e.g. collected at intervals during the beginning, middle and end of the operation. A sample of at least 10 L shall be collected, and a fraction may be subsampled for transport to the laboratory, provided it is representative of the sample and is a minimum of 1 L. A minimum of three 1 mL subsamples shall be analysed in full to enumerate organisms;
 - .2 control and treated discharged water shall be collected as one time-integrated sample over the duration of discharge from the tank(s). The sample may be collected as a single, continuous sample or a composite of sequential samples, e.g. collected throughout the beginning, middle and end of the operation. A sample of at least 10 L shall be collected, and a fraction may be subsampled for transport to the laboratory, provided it is representative of the sample and is a minimum of 1 L. A minimum of six 1 mL subsamples shall be analysed in full to enumerate organisms;
 - .3 the sample may not be concentrated for analysis unless the procedure is validated. Only organisms greater than 10 µm and less than 50 µm in minimum dimension shall be enumerated; and
 - .4 the full volume of the sample shall be analysed unless the total number of organisms is high, e.g. 100. In this case, the average density may be extrapolated based on a well-mixed subsample using a validated method; and
- .3 for the evaluation of bacteria:
- .1 for the influent and discharge samples, a minimum 10 L sample referred to in paragraphs 2.8.6.2.1 and 2.8.6.2.2 above, respectively, or another sample at least 10 L in volume and collected in a similar manner, should be used; a subsample of minimum 1 L may be transferred to a sterile container for analysis;

- .2 a minimum of three subsamples of appropriate volume taken from the 1 L subsample described above shall be analysed for colony forming units of bacteria listed in regulation D-2; and
- .3 the toxicogenic test requirements shall be conducted in an appropriately approved laboratory. If no approved laboratory is available, the analysis method may be validated to the satisfaction of the Administration.

2.44 The samples shall be analysed as soon as possible after sampling, and analysed live within six hours or treated in such a way so as to ensure that proper analysis can be performed.

2.45 If in any test cycle the discharge results from the control water is of a concentration less than or equal to 10 times the values in regulation D-2.1, the test cycle is invalid.

Temperature

2.46 The effective performance of BWMS through a ballast water temperature range of 0°C to 40°C (2°C to 40°C for fresh water) and a mid-range temperature of 10°C to 20°C shall be the subject of an assessment verified by the Administration.

2.47 This assessment may include:

- .1 testing during land-based, shipboard, laboratory or bench-scale testing; and/or
- .2 the use of existing data and/or models, provided that their source, suitability and reliability is reported.

2.48 The report submitted to the Administration shall contain all documentation (including procedures, methods, data, models, results, explanations and remarks) associated with the temperature assessment. The report shall include at least the information identified in paragraph 2.57 of this annex.

Evaluation of regrowth

2.49 The evaluation of the regrowth of organisms shall be undertaken to the satisfaction of the Administration in land-based and/or shipboard testing in at least two test cycles in each salinity.

2.50 In the case of land-based testing being performed with a holding time of less than five days, a sufficient volume of treated uptake water shall be held under conditions similar to conditions in the relevant holding tank. In the case of shipboard testing, water shall be retained on board for the evaluation of regrowth during a shipboard test cycle. Additional bench-scale testing may be used to supplement the land-based and/or shipboard testing.

2.51 In the case of a BWMS that includes mechanical, physical, chemical and/or biological processes intended to kill, render harmless or remove organisms within ballast water at the time of discharge or continuously between the time of uptake and discharge, regrowth shall be assessed in accordance with sections "Shipboard tests" and "Land-based testing" of this annex with a holding time of at least five days.

2.52 Otherwise, the enumeration of organisms to assess regrowth shall be undertaken at least five days after the completion of all of the mechanical, physical, chemical and/or biological processes intended to kill, render harmless or remove organisms within ballast water.

2.53 Any neutralization of ballast water required by the BWMS shall occur at the end of the holding time and immediately before the enumeration of organisms.

2.54 The evaluation of regrowth is not intended to evaluate contamination in ballast tanks or piping, such as may arise from the presence of untreated water or residual sediments.

2.55 A report shall be submitted to the Administration containing all documentation (including procedures, methods, data, models, results, explanations and remarks) associated with the evaluation of regrowth. The report shall include at least the information identified in paragraph 2.57 of this annex.

Reporting of test results

2.56 After approval tests have been completed, a report shall be submitted to the Administration. This report shall include information regarding the test design, methods of analysis and the results of these analyses for each test cycle (including invalid test cycles), BWMS maintenance logs and any observed effects of the BWMS on the ballast system of the ship (e.g. pumps, pipes, tanks, valves). Shipboard test reports shall include information on the total and continuous operating time of the BWMS.

2.57 The reports submitted in accordance with paragraph 2.56 above shall contain at least the following information:

- .1 the name and address of the laboratory performing or supervising the inspections, tests or evaluations, and its national accreditation or quality management certification, if appropriate;
- .2 the name of the manufacturer;
- .3 the trade name, product designation (such as model numbers), and a detailed description of the equipment or material inspected, tested or evaluated;
- .4 the time, date, and place of each approval inspection, test or evaluation;
- .5 the name and title of each person performing, supervising, and witnessing the tests and evaluations;
- .6 executive summary;
- .7 introduction and background;
- .8 for each test cycle, inspection or evaluation conducted, summary descriptions of:
 - .1 experimental design;
 - .2 methods and procedures;
 - .3 results and discussion, including a description of any invalid test cycle (in the case of a report referred to in Part 2 of this annex) and a comparison to the expected performance; and

- .4 in the case of land-based testing, test conditions including details on challenge water preparation in line with paragraph 2.30 of this annex;
- .9 a description or photographs of the procedures and apparatus used in the inspections, tests or evaluation, or a reference to another document that contains an appropriate description or photographs;
- .10 at least one photograph that shows an overall view of the equipment or material tested, inspected or evaluated and other photographs that show:
 - .1 design details; and
 - .2 each occurrence of damage or deformation to the equipment or material that occurred during the approval tests or evaluations;
- .11 the operational safety requirements of the BWMS and all safety-related findings that have been made during the inspections, tests or evaluations;
- .12 an attestation that the inspections, tests or evaluations were conducted as required and that the report contains no known errors, omissions or false statements. The attestation must be signed by the chief officer of the laboratory, or the chief officer's representative;
- .13 appendices, including:
 - .1 the complete test plan and the data generated during tests and evaluations reported under paragraph 2.57.8 above, including at least:
 - .1 for land-based tests, whether ambient, cultured or a mixture of test organisms have been used (including a species-level identification for cultured organisms, and an identification to the lowest possible taxonomic level for ambient organisms);
 - .2 for shipboard tests, the operating parameters of the system during successful treatment operations (e.g. dosage rates, ultraviolet intensity and the energy consumption of the BWMS under normal or tested TRC, if available);
 - .3 for SDL, details of all procedures, methods, data, models, results, explanations and remarks, leading to validation; and
 - .4 invalid test information.
 - .2 the QMP, the QAPP and quality assurance and quality control records;
 - .3 maintenance logs including a record of any consumable components that were replaced; and
 - .4 relevant records and test results maintained or created during testing.

2.58 The results of biological efficacy testing of the BWMS shall be accepted if during the land-based and shipboard testing conducted as specified in sections "Shipboard tests" and "Land-based testing" of this annex it is shown that the system has met the standard in regulation D-2 and that the uptake water quality requirements were met in all individual test cycles as provided in paragraph 4.7 below.

2.59 The test report shall include all test cycles during land-based and shipboard tests, including failed test cycles and invalid test cycles with the explanation required in 2.8.11.4 for both shipboard and land-based tests.

2.60 The Administration shall identify and redact commercially sensitive information (information that is proprietary and not related to the BWMS performance) and make all other information available to interested parties and the Organization. The information shall include all of the test reports, including failed tests from both land-based and shipboard testing.

PART 3 – SPECIFICATION FOR ENVIRONMENTAL TESTING FOR APPROVAL OF BALLAST WATER MANAGEMENT SYSTEMS

3.1 The electrical and electronic sections of the BWMS in the standard production configuration shall be subject to the relevant tests specified in paragraph 3.3 below at a laboratory approved for the purpose by the Administration or by the accreditation body of the laboratory, with relevant accreditation covering the relevant test standards.

3.2 Evidence of successful compliance with the environmental tests below shall be submitted to the Administration by the manufacturer together with the application for type approval.

3.3 Equipment is to be tested taking into account international test specifications for type approval.

3.4 A report on environmental tests shall be submitted to the Administration and include at least the information identified in paragraph 2.57 of this Annex.

PART 4 – SAMPLE ANALYSIS METHODS FOR THE DETERMINATION OF BIOLOGICAL CONSTITUENTS IN BALLAST WATER

Sample processing and analysis

4.1 Samples taken during testing of BWMS are likely to contain a wide taxonomic diversity of organisms, varying greatly in size and susceptibilities to damage from sampling and analysis.

4.2 When available, widely accepted standard methods for the collection, handling (including concentration), storage, and analysis of samples should be used. These methods shall be clearly cited and described in test plans and reports. This includes methods for detecting, enumerating, and determining minimum dimension of and identifying organisms and for determining viability (as defined in this Code).

4.3 When standard methods are not available for particular organisms or taxonomic groups, methods that are developed for use shall be described in detail in test plans and reports. The descriptive documentation shall include any experiments needed to validate the use of the methods.

4.4 Given the complexity in samples of natural and treated water, the required rarity of organisms in treated samples under regulation D-2, and the expense and time requirements of current standard methods, it is likely that several new approaches will be developed for the analyses of the composition, concentration and viability of organisms in samples of ballast water. Administrations/Parties are encouraged to share information concerning methods for the analysis of ballast water samples, using existing scientific venues, and documents distributed through the Organization.

Sample analysis for determining efficacy in meeting the discharge standard

4.5 Sample analysis is meant to determine the species composition and the number of viable organisms in the sample. Different samples may be taken for determination of viability and for species composition.

4.6 The viability of organisms shall be determined taking into account guidance developed by the Organization using methodologies appropriate to the ballast water treatment technology being tested. Such methodologies shall provide assurance that organisms not removed from ballast water have been killed or rendered harmless to the environment, human health, property and resources. Viability may be established by assessing the presence of one or more essential characteristics of life, such as structural integrity, metabolism, reproduction, motility or response to stimuli.

4.7 A treatment test cycle shall be deemed successful if:

- .1 it is valid in accordance with paragraph 2.8.5 (shipboard) or 2.29, 2.30, 2.33 and 2.47 (land-based testing) of this annex as appropriate;
- .2 the density of organisms greater than or equal to 50 µm in minimum diameter in the replicate samples is less than 10 viable organisms per cubic metre;
- .3 the density of organisms less than 50 µm and greater than or equal to 10 µm in minimum diameter in the replicate samples is less than 10 viable organisms per mL;
- .4 the density of *Vibrio cholerae* (serotypes O1 and O139) is less than 1 cfu per 100 ml, or less than 1 cfu per 1 g (wet weight) zooplankton samples;
- .5 the density of *E. coli* in the replicate samples is less than 250 cfu per 100 mL;
- .6 the density of Intestinal Enterococci in the replicate samples is less than 100 cfu per 100 mL; and
- .7 no averaging of test cycles, or the discounting of failed test cycles, has occurred.

4.8 It is recommended that a non-exhaustive list of standard methods and innovative research techniques be considered.

Sample analysis for determining eco-toxicological acceptability of discharge

4.9 Toxicity tests of the treated water discharge shall be conducted taking into account guidelines developed by the Organization.

PART 5 – SELF-MONITORING

Introduction

5.1 BWMS shall monitor and store a minimum number of parameters for detailed evaluation. In addition, all system indications and alerts shall be stored and available for inspection. Data storage and retrieval shall follow common standards. This part gives an overview of the minimum required self-monitoring parameters.

Monitoring of parameters

5.2 The applicable self-monitoring parameters listed below shall be recorded for every BWMS. Any additional parameters that are necessary to ascertain system performance and safety shall be determined by the Administration and stored in the system. If a parameter is not applicable due to the particulars of the system, the Administration may waive the requirement to record that parameter. Limiting operating conditions on the operation of the BWMS shall be determined by the manufacturer and approved by the Administration.

General information for all systems

5.3 The information and applicable self-monitoring parameters to be recorded for all systems shall include, inter alia:

- .1 general information: ship name, IMO number, BWMS manufacturer and type designation, BWMS serial number, date of BWMS installation on ship, BWMS TRC and principle of treatment (in-line/in-tank);
- .2 operational parameters: all recorded parameters should be time tagged if applicable: BWMS operational modes and any transition modes, including bypass operations (e.g. uptake, discharge, warming-up, cleaning and start up), ballast water pump in operation (yes/no – if information is available from ship), flow-rate at system outlet, and indication of the ballast water tank that is involved in the ballast water operation when practicable;
- .3 it is recommended that positional information on ballast water operations and on the holding time should be recorded automatically. Otherwise it shall be entered manually in the ballast water record book as appropriate. Administrations are encouraged to apply automatic position information recording to ships which install BWMS during a ship's building to the greatest extent possible;
- .4 system alerts and indications: all systems shall have an alert regime. Every alert shall be logged and time stamped. To assist the inspections it would be helpful to record an alert summary after each ballast water operation automatically, if possible;
- .5 general alerts include: shutdown of system while in operation, when maintenance is required, BWMS bypass valve status and status of BWMS valves representing system operational mode as appropriate;

- .6 operational alerts: whenever a relevant parameter exceeds the acceptable range approved by the Administration, the system shall give an alert. In addition, an alert shall be logged and time stamped also when a combination of relevant parameters exceeds system specifications, even if each single parameter does not exceed its approved range. If a safety relevant parameter (safety for crew, cargo and/or the ship) related to the BWMS exceeds approved limits, an alert/alarm shall be mandatory (e.g. hydrogen level at appropriate measurement point(s));
- .7 the Administration may require additional alerts depending on the design of the system and for future developments; and
- .8 the SDL parameters and their corresponding data such as range, alarm limit, alert delay, etc., be password protected on a level above what is required for normal operation and maintenance, i.e. on a system administrator level. Change of any data or parameters which are password protected and interruption of the measurement (wire break, signal out of range) shall be automatically logged and retrievable on a maintenance access level.

Data storage and retrieval

5.4 Storage of data shall follow the requirements in paragraphs 4.17 to 4.22 of this Code. The equipment shall be able to store a minimum number of self-monitoring parameters following common standards determined by the Organization.

5.5 The control and monitoring equipment shall automatically record the proper functioning or failure of a BWMS without user interaction and add a time stamp to every entry. Additionally, the system shall have a tool to produce summary text files for each ballast water operation on demand to support inspections work.

5.6 The system shall store the required data in an acceptable format to be able to display, print or export the data for official inspections. An acceptable format could be:

- .1 an internationally standardized readable format (e.g. text format, pdf, MS Excel); or
- .2 the extensible mark-up language (xml).

5.7 The equipment shall be so designed that, as far as is practical, it will not be possible to manipulate either the data being stored by the system or the data which has already been recorded. Any attempt to interfere with the integrity of the data shall be recorded.

5.8 Permanent deletion of recordings shall not be possible. The system shall be capable of storing recorded data for at least 24 months to facilitate compliance with regulation B-2 of the Convention. Where navigation equipment is connected to the monitoring system to provide data for recording, the interfaces shall be developed taking into account applicable parts of relevant international standards.

PART 6 – VALIDATION OF SYSTEM DESIGN LIMITATIONS

6.1 The objective of the SDL approach is twofold. Firstly, it ensures that the performance of the BWMS has been transparently assessed with respect to the known water quality and operational parameters that are important to its operation, including those that may not be specifically provided for in this Code. Secondly, it provides transparent oversight of BWMS performance claims by the manufacturer that may go beyond specific criteria in this Code. Although the validation of SDL yields information that is reported on the Type Approval Certificate, this information does not affect the eligibility of a BWMS to receive type approval.

6.2 The low and/or high parameter values for each SDL shall be validated to the satisfaction of the Administration as follows:

- .1 the validation shall be overseen by the Administration and shall consist of a rigorous evidence-based assessment of a specific claim by the BWMS manufacturer that the equipment will operate as intended between pre-stated parameter values;
- .2 tests to validate SDL shall be undertaken in accordance with paragraphs 2.2 to 2.4 of this annex. Such tests may be combined with land-based and/or shipboard testing if the QAPP establishes that the validation tests will not interfere with the specific procedures in Part 2 of this annex. Laboratory or bench-scale testing may also be used in the validation of SDL;
- .3 methods other than testing, such as the use of existing data and/or models, may be used in the validation of SDL. The source, suitability and reliability of such methods shall be reported; and
- .4 validation is not intended as a stress-test of the BWMS or as a procedure for identifying equipment failure points. Validation shall be undertaken independently of the BWMS manufacturer and shall be separate from BWMS research and development activities. Data and models may be supplied by the manufacturer when appropriate but shall be independently assessed.

6.3 Claims of open-ended performance (expressed as the lack of either a low or a high parameter value for a System Design Limitation) shall also be validated.

6.4 BWMS manufacturers may include a margin of error in claiming SDL. For this reason, SDL should not necessarily be interpreted as the exact parameter values beyond which the BWMS is incapable of operation. The Administration shall take this into account in considering whether to include any additional restrictions on the Type Approval Certificate in connection with the validation of SDL.

6.5 SDL shall be established for all known parameters to which the design of the BWMS is sensitive that are important to the operation of the BWMS. In the case of SDL parameters that are also subject to specific criteria in Part 2 of this annex, the procedure set out in Part 2 shall be followed. For such parameters, the approach in paragraph 6.2 above may be used only to the extent that the performance claim goes beyond the specific criteria in Part 2.

6.6 A report shall be submitted to the Administration containing all documentation (including procedures, methods, data, models, results, explanations and remarks) associated with the validation of SDL. The report shall include at least the information identified in paragraph 2.57 of this annex.

PART 7 – TYPE APPROVAL CERTIFICATE AND TYPE APPROVAL REPORT

Type Approval Certificate

7.1 The Type Approval Certificate of a BWMS shall:

- .1 identify the type and model of the BWMS to which it applies and identify equipment assembly drawings, duly dated;
- .2 identify pertinent drawings bearing model specification numbers or equivalent identification details;
- .3 include a reference to the full performance test protocol on which it is based;
- .4 identify if it was issued by an Administration based on a Type Approval Certificate previously issued by another Administration. Such a certificate shall identify the Administration that supervised conduction of the tests on the BWMS and a copy of the original test results shall be attached to the Type Approval Certificate of the BWMS;
- .5 identify all conditions and limitations for the installation of BWMS on board the ship;
- .6 include the SDL, which shall be listed under the heading "This equipment has been designed for operation in the following conditions";
- .7 include any restrictions imposed by the Administration due to the minimum holding time or in accordance with paragraph 6.4 of this annex; such restrictions shall include any applicable environmental conditions (e.g. UV transmittance, etc.) and/or system operational parameters (e.g. min/max pressure, pressure differentials, min/max Total Residual Oxidants (TRO) if applicable, etc.); and
- .8 include an appendix containing test results of each land-based and shipboard test cycle. Such test results shall include at least the numerical salinity, temperature, flow rates, and where appropriate UV transmittance. In addition, these test results shall include all other relevant variables. The Type Approval Certificate shall list any identified SDL parameters.

Type approval report

7.2 The type approval report shall be submitted to the Organization and made available to the public and Member States by appropriate means. It shall contain at least:

- .1 information on the type approval of the BWMS, including:
 - .1 the approval date;
 - .2 the name of the Administration;
 - .3 the name of the manufacturer;
 - .4 the trade name and product designation (such as model numbers) of the BWMS; and
 - .5 a copy of the Type Approval Certificate including its appendices, annexes or other attachments;

- .2 an executive summary;
- .3 a description of the BWMS, including, in the case of BWMS using Active Substances, the following information:
 - .1 the name of the Active Substance(s) or Preparation(s) employed; and
 - .2 identification of the specific Marine Environment Protection Committee (MEPC) report and paragraph number granting Final Approval, taking into account guidelines developed by the Organization;
- .4 an overview of the process undertaken by the Administration to evaluate the BWMS, including the name and role of each test facility, subcontractor and test organization involved in testing and approving the BWMS, the role of each report in the type approval decision, and a summary of the Administration's approach to overall quality assurance and quality control;
- .5 the executive summary of each test report prepared in accordance with paragraphs 2.48, 2.55 to 2.57, 3.4 and 6.6 of this Annex;
- .6 the operational safety requirements of the BWMS and all safety-related findings that have been made during the type approval process;
- .7 a discussion section explaining the Administration's assessment that the BWMS:
 - .1 in every respect fulfilled the requirements of this Code, including demonstrating under the procedures and conditions specified for both land-based and shipboard testing that it met the ballast water performance standard described in regulation D-2;
 - .2 is designed and manufactured according to requirements and standards;
 - .3 is in compliance with all applicable requirements;
 - .4 has been approved taking into account the recommendations provided by the MEPC in the Final Approval of the BWMS, if any;
 - .5 operates within the SDL at the TRC, performance, and reliability as specified by the manufacturer;
 - .6 contains control and monitoring equipment that operates correctly;
 - .7 was installed in accordance with the technical installation specification of the manufacturer for all tests; and
 - .8 was used to treat volumes and flow rates of ballast water during the shipboard tests consistent with the normal ballast operations of the ship; and

.8 the following annexes:

- .1 appropriate information on quality control and assurance; and
- .2 each complete test report prepared in accordance with paragraphs 2.48, 2.55 to 2.57, 3.4 and 6.6 of this annex.

7.3 The Administration may redact proprietary information of the manufacturer from the type approval report before submitting it to the Organization.

7.4 The Type Approval Certificate and the type approval report (including their entire contents and all annexes, appendices or other attachments) shall be accompanied by a translation into English, French or Spanish if not written in one of those languages.

7.5 Documents shall not be incorporated by reference into the Type Approval Certificate. The Administration may incorporate an annex by reference into the type approval report if the reference (e.g. internet URL) is expected to remain permanently valid. Upon any reference becoming invalid, the Administration shall promptly re-submit the type approval report to the Organization and include the referenced document or an updated reference to it; and the Organization shall promptly make the revised report available to the public and Member States through appropriate means.

APPENDIX

BADGE OR CIPHER

(Limiting Operating Conditions apply)*

NAME OF ADMINISTRATION

TYPE APPROVAL CERTIFICATE OF BALLAST WATER MANAGEMENT SYSTEM

This is to certify that the ballast water management system listed below has been examined and tested in accordance with the requirements of the specifications contained in the *Code for Approval of Ballast Water Management Systems* (resolution MEPC.300(72)). This certificate is valid only for the ballast water management system referred to below.

Name of ballast water management system:

Ballast water management system manufactured by:

Under type and model designation(s)
and incorporating:

To equipment/assembly drawing No.: date:

Other equipment manufactured by:

To equipment/assembly drawing No.: date:

Treatment Rated Capacity (m³/h):

A copy of this Type Approval Certificate shall be carried on board a ship fitted with this ballast water management system, for inspection on board the ship. If the Type Approval Certificate is issued based on approval by another Administration, reference to that Type Approval Certificate shall be made.

Limiting Operating Conditions imposed are described in this document.

(Temperature / Salinity)

Other restrictions imposed include the following:

This equipment has been designed for operation in the following conditions:**

Official stamp

Signed
Administration of
Issued this day of 20
Valid until this day of 20

* Delete as appropriate.

** Insert System Design Limitations.